ACKNOWLEDGEMENTS

The Canadian Institute for Health Information and the Canadian Patient Safety Institute have collaborated on a body of work to address gaps in measuring harm and to support patient safety improvement efforts in Canadian hospitals.

The Hospital Harm Improvement Resource was developed by the Canadian Patient Safety Institute to complement the Hospital Harm measure prepared by the Canadian Institute for Health Information. It links measurement and improvement by providing evidence-informed resources that will support patient safety improvement efforts.

The Canadian Patient Safety Institute acknowledges and appreciates the key contributions of Dr. Denny Laporta (Jewish General Hospital) for the review and approval of this Improvement Resource.
### D25: Procedure-Associated Shock

<table>
<thead>
<tr>
<th>Concept</th>
<th>Code descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selection criteria</td>
<td>T81.1 Identified as diagnosis type (2) AND Y60-84 in the same diagnostic cluster</td>
</tr>
<tr>
<td>Codes</td>
<td>Code descriptions</td>
</tr>
<tr>
<td>T81.1</td>
<td>Shock during or resulting from a procedure, not elsewhere classified</td>
</tr>
<tr>
<td>Additional Codes:</td>
<td>INCLUSIONS</td>
</tr>
<tr>
<td>Y60-84</td>
<td>Complications of medical and surgical care (refer to Appendix 6 in the CIHI Methodology Manual).</td>
</tr>
</tbody>
</table>
OVERVIEW AND IMPLICATIONS

Shock is a condition of inadequate tissue perfusion. It is a clinical state that occurs when a mismatch arises between oxygen supply and metabolic demand, resulting in cellular hypoxia. If not recognized and treated appropriately, shock will ultimately progress to organ failure (Broussard & Ural, 2018; Gaieski & Mikkelsen, 2018; Vincent et al. 2013). It is one of the leading causes of death in hospitalized patients (Nichol & Ahmed, 2014).

There are several types of shock that a patient may experience during or after a procedure. Shock may be present when cardiac output is either decreased (low-flow) or increased (high-flow); examples of low-flow shock states are hypovolemic, cardiac and obstructive shock, whereas a high-flow shock state occurs in cases of distributive shock (Cecconi, 2014).

Table 1 below was created by Dr. Denny Laporta at the Jewish General Hospital, McGill University in Quebec (Laporta, 2018). The table summarizes the various types of shock that may be encountered in the peri-procedure period. In hypovolemic shock the reduced cardiac output is due to a reduction in circulating volume and consequent venous return. It may be due to hemorrhage or when large volumes of fluid are lost perioperatively – expectedly or unexpectedly.

Cardiogenic shock refers to cardiac pump failure. In other words, the heart is unable to pump enough blood to meet the body’s demand for oxygen. Cardiogenic shock is most often caused by myocardial infarction, which may in turn be precipitated by physiologic stress associated with a procedure. Cardiac valvular disease or cardiomyopathy may also be contributing causes.

Distributive shock is when blood vessels dilate inappropriately, or more seriously, dilate and leak. Severe sepsis is the predominant form of distributive shock. Other disorders characterized by an acute and intense systemic inflammatory response (SIRS) such as anaphylaxis, comprise most – but not all - of the other causes of distributive shock occurring in the peri-procedure period.

Table 1: Examples of shock occurring during or after a procedure

<table>
<thead>
<tr>
<th>Hypovolemic</th>
<th>Cardiogenic</th>
<th>Obstructive</th>
<th>Distributive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bleeding</td>
<td>Myocardial Infarction</td>
<td>Pulmonary embolism</td>
<td>Septic syndrome</td>
</tr>
<tr>
<td>Excess loss of non-blood fluid</td>
<td>Pre-existing</td>
<td>Tension pneumothorax</td>
<td>Other (non-infectious) causes of systemic inflammatory response (SIRS)</td>
</tr>
<tr>
<td>- Drainage</td>
<td>- Cardiomyopathy</td>
<td></td>
<td>- Anaphylaxis</td>
</tr>
<tr>
<td>- 3rd-spacing</td>
<td>(hypertrophic dilated)</td>
<td></td>
<td>- Transfusion reaction</td>
</tr>
<tr>
<td></td>
<td>- Valvulopathy</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Other adverse drug reactions</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Antihypertensives</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Anethetics</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cardiac tamponade</td>
<td></td>
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<tr>
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</tbody>
</table>

December 2018
**HOSPITAL HARM IMPROVEMENT RESOURCE**  
Procedure-Associated Shock

<table>
<thead>
<tr>
<th>Hypovolemic</th>
<th>Cardiogenic</th>
<th>Obstructive</th>
<th>Distributive</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Adrenal insufficiency (chronic steroid use)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Miscellaneous</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Burns</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Liver failure</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Thyroid storm</td>
</tr>
</tbody>
</table>

*These may occur as single causes or in combination

**GOAL**

Reduce the incidence of procedure-associated shock.

**IMPORTANCE FOR PATIENTS AND FAMILIES**

Procedure related shock can cause serious harm and death if not treated quickly. Knowing the signs to watch for, along with a prompt and appropriate response, can help save lives.

Family members will often identify changes in the patient’s alertness and level of awareness; as well as the patient’s restlessness and agitation. Deterioration may not be recognized or acted upon by healthcare providers, resulting in preventable patient safety incidents. Monitoring, observation, family consultation and communication are key to managing this risk (HIROC, 2016).

**Patient Story**

Hear, and feel free to share Erin’s and Jen’s powerful stories via “Sepsis Emergency™” as provided by the Sepsis Alliance. [https://www.youtube.com/watch?v=DnsQ4RIxsZY](https://www.youtube.com/watch?v=DnsQ4RIxsZY)

**EVIDENCE INFORMED PRACTICE**

1. **Staff Education**

   Educate all staff caring for patients before, during and after procedures about:
   - normal post-procedural fluid requirements (Siparsky 2016)
   - signs and symptoms of shock (Gaieski & Mikkelsen, 2018, “Evaluation”)
   - potential causes of procedure-associated shock and related risk factors
   - causes/risk factors for procedures certain staff may be specifically involved with (see examples in the References section: Additional Guidelines – Condition Specific Guidelines which may be helpful in the prevention of shock). These factors may relate to the patient, procedure or healthcare environment.
For example, hemorrhagic shock, perhaps the most common cause of hypovolemic shock in surgical patients, can be categorized according to the severity of acute blood loss as per Table 2 below (American College of Surgeons, 2018).

Table 2: Signs and Symptoms of Hemorrhage by Class

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Class I</th>
<th>Class II (Mild)</th>
<th>Class III (Moderate)</th>
<th>Class IV (Severe)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approximate blood loss</td>
<td>&lt;15%</td>
<td>15-30%</td>
<td>31-40%</td>
<td>&gt;40%</td>
</tr>
<tr>
<td>Heart rate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blood pressure</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pulse pressure</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respiratory rate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urine output</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glasgow Coma Scale score</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Base deficit*</td>
<td>0 to -2 mEq/L</td>
<td>-2 to -6 mEq/L</td>
<td>-6 to -10 mEq/L</td>
<td>-10 mEq/L or less</td>
</tr>
<tr>
<td>Need for blood products</td>
<td>Monitor</td>
<td>Possible</td>
<td>Yes</td>
<td>Massive Transfusion Protocol</td>
</tr>
</tbody>
</table>

*Base excess is the quantity of base (HCO$_3^-$, in mEq/L) that is above or below the normal range in the body. A negative number is called a base deficit and indicates metabolic acidosis.


2. Perioperative Blood Management (PBM)

Assessment and Management Peri-operative bleeding, the most common cause of post-procedural hypovolemic shock, requires specific recognition. Best practices relating to perioperative patient blood management and postoperative hemorrhage may include Perioperative Blood Management (PBM), whereby pre- intra- and post- procedure strategies are targeted to minimize the risk of perioperative blood loss and transfusion requirements. (American Society of Anesthesiologists et al 2015; Clevenger et al. 2015; Graetz & Nuttall, 2017; Hohmuth et al. 2014; National Blood Authority, 2012). For additional information, please refer to the Hospital Harm Improvement Resource - Procedure Associated Anemia-Hemorrhage.

One approach, supported by the American Society of Anesthesiologists (2015), recommends:
A. Patient Evaluation

Review previous medical records and interview the patient or family to identify history of previous blood transfusion, drug-induced coagulopathy or thrombotic events, and the presence of congenital coagulopathy or of risk factors for organ ischemia. Review available laboratory test results including Hb, Hct, and coagulation profiles. Order additional laboratory tests depending on a patient’s medical condition. Conduct a physical examination of the patient. If possible, perform the preoperative evaluation well enough in advance to allow for proper patient preparation.

Additional resources regarding Patient Evaluation:
   i) Identifying bleeding risk and managing patients with bleeding disorders (of coagulation or platelet function) (AHRQ, 2013, PSI; Chee et al. 2008; De Hert et al. 2011; Douketis et al. 2012; Koscielny et al. 2004)
   ii) Identifying risk factors and mitigating practices for post-procedural blood loss (WHO, 2009)

B. Preadmission Patient Preparation

Consider administration of erythropoietin with or without iron when possible to reduce the need for allogeneic blood in selected patient populations. Administer iron to patients with iron deficiency anemia if time permits. In consultation with an appropriate specialist, discontinue anticoagulation therapy for elective surgery. If clinically possible, discontinue non-aspirin antiplatelet agents for a sufficient time in advance of surgery, except for patients with a history of percutaneous coronary interventions. Consider the risk of thrombosis versus the risk of increased bleeding when altering anticoagulation status. Assure that blood and blood components are available for patients when significant blood loss or transfusion is expected. When autologous blood is preferred, the patient may be offered the opportunity to donate blood before admission only if there is adequate time for erythropoietic reconstitution.

C. Preprocedure Preparation

Implement evidence informed protocols for/regarding:
   i) patient blood management
   ii) reversal of anticoagulants
   iii) the use of antifibrinolytics for prophylaxis of excessive blood loss
   iv) the use of Acute Normovolemic Hemodilution (ANH)

D. Intraoperative and Postoperative Management of Blood Loss

Implement evidence informed protocols for/regarding:
   i) allogeneic red blood cell transfusion
   ii) reinfusion of recovered red blood cells
   iii) intraoperative and postoperative patient monitoring
   iv) treatment of excessive bleeding
Additional resources regarding intraoperative and postoperative management of blood loss:

i) Timely management of post-procedural shock and overall management of blood loss. (Hrymak et al. 2017; Cecconi et al. 2014; Gaieski & Mikkelsen, 2018; Rhodes et al. 2017; Vincent et al. 2013)

ii) Overall management of blood loss (AHRQ, 2013; PSI 09; Dagi, 2005)


3. Sepsis Management

As for other causes of procedure-associated shock, providers must be educated about anticipating, preventing, early recognition and timely intervention of a sepsis syndrome. For details, please refer to the Sepsis Hospital Harm Improvement Resource. An update from the same group has been recently published (Rhodes et al. 2017).

4. Organizational Practices

Organizational practices that promote and facilitate the prevention, early recognition and timely management intervention of procedure related shock may span over a wide spectrum of care processes and, as mentioned previously, will vary according to patient case mix, procedures performed and the environment in which they are performed.

Early warning signs of deteriorating condition are often unrecognized, leading to devastating results. Research shows that virtually all critical inpatient events are preceded by warning signs that occur approximately six-and-a-half hours in advance. On the Canadian Patient Safety Institute’s webpage – Deteriorating Patient Condition, you will find information, tools and resources to not only help you recognize deteriorating patient condition, but what you can do to act on it as a member of the public, a healthcare provider or leader.

According to AHRQ’s Patient Safety Indicator – Postoperative hemorrhage or hematoma (2013), a first step is to engage key preoperative/perioperative/procedure personnel, including nurses, physicians and other providers, surgical technicians, and representatives from the quality improvement department to adapt, adopt or develop evidence-based protocols for care of the patient preoperatively, intraoperatively, and postoperatively.

The above team:

- Identifies the purpose, goals, and scope and defines the target population for this guideline.

- Analyzes problems with guidelines compliance, identifies opportunities for improvement, and communicates best practices to frontline teams.

- Monitors measures that would indicate if changes are leading to improvement, identifies process and outcome metrics, and tracks performance using these metrics.
• Determines appropriate facility resources for effective and permanent adoption of practices.

An example of organizational practices for the early recognition of procedure-associated shock is:

• **Early Warning Signs (EWS):** consider developing a standard set of criteria or EWS that will be used to trigger notification of the responsible physician of possible procedure-associated shock. Incorporate these into a tool designed to provide standardized documentation of all pertinent details of the event. This tool will provide the data to track patient characteristics, processes, and outcomes for continuous quality improvement.

• **Policy:** establish a policy to empower nurses to rapidly escalate up the chain of authority to reach the responsible physician or practitioner/provider (example: limit time to five-minute wait after initial page before moving to notify next higher level of authority).

• **Education:** provide educational sessions to all clinical staff on the pilot units (nurses, residents, attending physicians, other providers, respiratory therapists, patient care technicians, certified nursing assistants, etc.) in the use of the early warning signs criteria, required documentation, and policy for rapid escalation up the chain of authority to notify responsible physician or practitioner/provider.

At a broader level, the organization may:

• provide education on protocols to physician, nursing, and all other staff involved in operative, procedural cases and the care of patients postoperatively. Education should occur upon hire, annually, and when this protocol is added to job responsibilities.

For additional Mitigation Strategies, please refer to the HIROC Risk Reference Sheet Failure to Appreciate Status Changes/Deteriorating Patients (HIROC, 2016).

**Conduct Clinical and System Reviews**

Given the broad range of potential causes of complications from procedure-associated shock, in addition to the recommendations listed above, we recommend conducting clinical and system reviews to identify latent causes and determine appropriate recommendations.

If your review reveals that your cases of procedure-associated shock are linked to specific processes or procedures, you may find guidelines related to the specific procedure in the Additional Resources section.
CLINICAL AND SYSTEM REVIEWS, INCIDENT ANALYSES

Occurrences of harm are often complex with many contributing factors. Organizations need to:

1. Measure and monitor the types and frequency of these occurrences.
2. Use appropriate analytical methods to understand the contributing factors.
3. Identify and implement solutions or interventions that are designed to prevent recurrence and reduce risk of harm.
4. Have mechanisms in place to mitigate consequences of harm when it occurs.

To develop a more in-depth understanding of the care delivered to patients, chart audits, incident analyses and prospective analyses can be helpful in identifying quality improvement opportunities. Links to key resources for analysis methods are included in Resources for Conducting Incident and/or Prospective Analyses section of the Introduction to the Hospital Harm Improvement Resource.

Chart audits are recommended as a means to develop a more in-depth understanding of the care delivered to patients identified by the Hospital Harm measure. Chart audits help identify quality improvement opportunities.

Useful resources for conducting clinical and system reviews:

- Chart Audit Review Process (see Introduction to the Improvement Resource)
- Canadian Incident Analysis Framework
- Canadian Patient Safety Institute Patient Safety and Incident Management Toolkit
- HIROC Critical Incident & Multi-Patient Events Risk Resource Guide
- Institute for the Safe Medication Practices Canadian Failure Mode and Effects Analysis Framework
- Institute for Healthcare Improvement Failure Mode and Effects Analysis Tool

MEASURES

Vital to quality improvement is measurement, and this applies specifically to implementation of interventions. The chosen measures will help to determine whether an impact is being made (primary outcome), whether the intervention is actually being carried out (process measures), and whether any unintended consequences ensue (balancing measures).

Below are some recommended measures to use, as appropriate, to track your progress. In selecting your measures, consider the following:

- Whenever possible, use measures you are already collecting for other programs.
Evaluate your choice of measures in terms of the usefulness of the final results and the resources required to obtain them; try to maximize the former while minimizing the latter.

Try to include both process and outcome measures in your measurement scheme.

You may use different measures or modify the measures described below to make them more appropriate and/or useful to your particular setting. However, be aware that modifying measures may limit the comparability of your results to others.

Posting your measure results within your hospital is a great way to keep your teams motivated and aware of progress. Try to include measures that your team will find meaningful and exciting (IHI, 2012).

For more information on measuring for improvement contact the Canadian Patient Safety Institute Central Measurement Team at measurement@cpsi-icsp.ca

**Outcome Measures**

1. Per cent of patients diagnosed with procedure-associated shock.

**Process Improvement Measures**

**Staff Education**

1. Per cent of staff having received training regarding management of signs and symptoms of shock and significant blood loss.

**Hypovolemic Shock**

1. For process measures for the prevention of hemorrhage related to medical or surgical care refer to the Procedure Associated Anemia – Hemorrhage Hospital Harm Improvement Resource.

2. Create and report additional process measures specific to the evidenced informed protocols being implemented for Intraoperative and Postoperative Management of Blood Loss.

**Septic Shock**

1. For process measures for the prevention and management of sepsis refer to the Sepsis Hospital Harm Improvement Resource.

**Organizational Practices**

1. Create and report additional process measures specific to the implementation of an early recognition and timely management deteriorating patient.
STANDARDS AND REQUIRED ORGANIZATIONAL PRACTICES

Health Standards Organization (HSO)

The standards sets most applicable to Procedure-Associated Shock are: Critical Care Services and Perioperative Services and Invasive Procedures.

GLOBAL PATIENT SAFETY ALERTS

Global Patient Safety Alerts (GPSA) provides access and the opportunity to learn from other organizations about specific patient safety incidents including alerts, advisories, recommendations and solutions for improving care and preventing incidents. Learning from the experience of other organizations can accelerate improvement.

Recommended search terms:

- Hemorrhage
- Anticoagulant
- Shock surgery
- Shock perforation

PROCEDURE-ASSOCIATED SHOCK SUCCESS STORY

Surviving Sepsis

In April 2008, a 70 year-old, independent lady with no previous comorbidities became a grandmother for the first time and was looking forward to watching her family grow up. She developed a cough and became breathless, and presented to her local hospital. She was admitted, and developed severe sepsis and septic shock secondary to her community-acquired pneumonia; she died within seven hours. Her sepsis was not recognized, and antibiotics and fluids were not given in a timely manner. The patient’s family and the well-meaning and competent medical and nursing team were devastated.

So begins the account of a real patient story that compelled Dr. Matt Inada-Kim and colleagues to tackle the problem of managing sepsis within their practice.....

REFERENCES


HOSPITAL HARM IMPROVEMENT RESOURCE
Procedure-Associated Shock


Gaieski DF, Mikkelsen ME. Evaluation of and initial approach to the adult patient with undifferentiated hypotension and shock. UpToDate. 2018 October, last updated.

Graetz TJ, Nuttall G. Preoperative evaluation and perioperative strategies to minimize blood transfusion. UpToDate. 2018 July, last updated.


Laporta D. Types of shock encountered in the peri-procedure period. Personal communication; 2018 Marc.


### PROCEDURE-ASSOCIATED SHOCK ADDITIONAL RESOURCES

Professional Associations and Helpful Websites

- Agency for Healthcare Research and Quality [www.ahrq.gov](http://www.ahrq.gov)
- National Institute for Health and Care Excellence (NICE) [www.nice.org.uk](http://www.nice.org.uk)
- Royal College of Anaesthetists [www.rcoa.ac.uk](http://www.rcoa.ac.uk)
Additional Guidelines: Condition-specific guidelines helpful in the prevention of shock

AHRQ. *Introduction to the toolkit for using the AHRQ quality indicators: How to improve hospital quality and safety.* AHRQ; 2013. Available at: https://www.ahrq.gov/sites/default/files/wysiwyg/professionals/systems/hospital/qitoolkit/combined/combined_toolkit.pdf


